(12) UK Patent Application (19) GB (11) 2 314 470 (13) A

(43) Date of A Publication 24.12.1997

(21) Application No 9612663.6

(22) Date of Filing 18.06.1996

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(51) INT CL[6]
H02J 7/00 , H01M 10/46 , H02J 7/02 // G06K 11/18

(52) UK CL (Edition O)
H2H HBCH H25G
H1B B1046
U1S S2204 S2424

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(58) Field of Search
UK CL (Edition O) H1B B1046 , H2H HBCD HBCE HBCF HBCG HBCH , H3Q QAB QBRX , H4L LAPS LECTX
INT CL[6] G06F 3/033 , G06K 11/06 11/18 11/20 , H01M 10/46 , H02J 7/00 7/02
ONLINE : WPI

(54) **Battery charging arrangement with inductively coupled charging device and rechargeable battery device**

(57) A battery (24, Figs. 1,2) of a rechargeable battery device 20 is connected to a secondary induction coil 21 which is displaceable relative to a primary induction coil 14 of a charging device 10, so that the battery (24) is charged when the coils 14 and 21 are located adjacent one another such that a current in the coil 14 can induce a current in coil 21. The battery (24) and coil 21 may be incorporated in an electrical product, particularly a wireless electrical product such as a remote control unit, eg. a wireless computer mouse 30.

The primary coil 14 is has a transistor driver (13, Figs. 1,2) receiving a pulse train from an oscillator (12), the oscillator (12) and driver (13) being powered by a DC power source (11) which incorporates a voltage regulator (113) for deriving a desired DC voltage from an AC or DC supply. The secondary coil 21 is connected to the battery (24) via rectifier and filter circuits (22, 23). The coils 14 and 21 are preferably planar spiral coils.

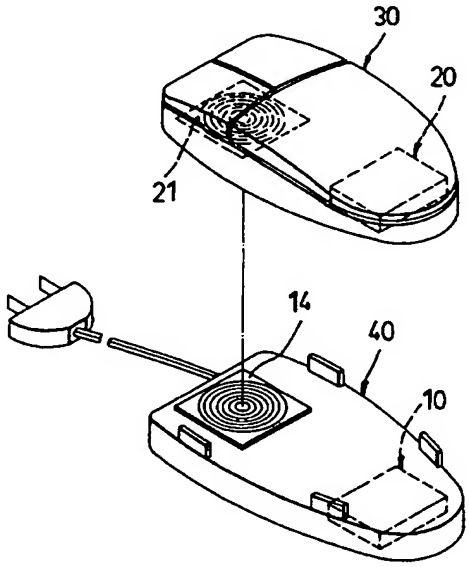

FIG.3

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RECHARGEABLE POWER SUPPLY WITH RECHARGEABLE BATTERY DEVICE AND CHARGING DEVICE, AND METHOD FOR CHARGING A RECHARGEABLE BATTERY DEVICE

The invention relates to a rechargeable power supply, more particularly to a rechargeable power supply which includes a rechargeable battery device and a charging device, and to a method for charging a rechargeable battery device.

A conventional rechargeable power supply includes a rechargeable battery device and a charging device. The charging device is provided with a pair of electrical contacts for connecting electrically with corresponding electrical contacts of the rechargeable battery device to permit the supply of electric current from the charging device to the rechargeable battery device. The electrical contacts of the charging device and the rechargeable battery device are susceptible to corrosion and deformation, thereby resulting in improper connection between the charging device and the rechargeable battery device which can adversely affect the charging operation.

The main object of the present invention is to provide a method for charging a rechargeable battery device which obviates the need for electrical contacts to overcome the aforementioned drawbacks of the prior art.

Another object of the present invention is to provide a rechargeable power supply which includes a rechargeable battery device and a charging device that utilize magnetic coupling to establish electrical connection therebetween.

Still another object of the present invention is to provide a charging device and a rechargeable battery device which incorporate induction coils for establishing magnetic coupling therebetween.

According to one aspect of the present invention, a method for charging a rechargeable battery device with a rechargeable battery cell comprises the steps of: providing the rechargeable battery device with a secondary induction coil which is connected electrically to the rechargeable battery cell; and providing a charging device with a primary induction coil which is displaceable with respect to the secondary induction coil and which is capable of generating a magnetic field for inducing electric current in the secondary induction coil when the primary induction coil is juxtaposed with the secondary induction coil.

According to another aspect of the present invention, a rechargeable power supply comprises: a rechargeable battery device which includes a rechargeable battery cell and a secondary induction coil connected electrically to the rechargeable battery

cell; and a charging device which includes a primary induction coil that is displaceable with respect to the secondary induction coil and that is capable of generating a magnetic field for inducing electric current in the secondary induction coil when the primary induction coil is juxtaposed with the secondary induction coil.

According to still another aspect of the present invention, a rechargeable battery device is to be charged by a magnetic field that is generated by a primary induction coil of a charging device. The rechargeable battery device comprises a rechargeable battery cell and a secondary induction coil connected electrically to the rechargeable battery cell. The secondary induction coil is displaceable with respect to the primary induction coil. The magnetic field that is generated by the primary induction coil induces electric current in the secondary induction coil when the secondary induction coil is juxtaposed with the primary induction coil.

According to a further aspect of the present invention, a charging device is used to charge a rechargeable battery device which includes a secondary induction coil connected electrically to a rechargeable battery cell. The charging device comprises a primary induction coil which is displaceable with respect to the secondary induction coil and which is capable of

generating a magnetic field for inducing electric current in the secondary induction coil when the primary induction coil is juxtaposed with the secondary induction coil.

Other features and advantages of the present invention will become apparent in the following detailed description of the preferred embodiment with reference to the accompanying drawings, of which:

Figure 1 is a schematic circuit block diagram of the preferred embodiment of a rechargeable power supply according to the present invention;

Figure 2 is a schematic electrical circuit diagram of the preferred embodiment; and

Figure 3 is a perspective view illustrating an intended application of the preferred embodiment.

Referring to Figures 1 and 2, the preferred embodiment of a rechargeable power supply according to the present invention is shown to comprise a charging device 10 and a rechargeable battery device 20.

The charging device 10 includes a DC power source 11, an oscillator circuit 12, a driving circuit 13 and a primary induction coil 14.

In this embodiment, the DC power source 11 is capable of converting an external AC line input into a desired DC voltage output. However, the DC power source 11 may be replaced by a circuit which converts an external DC input into the desired DC voltage output.

The DC power source 11 includes a plug 111 for connection to an AC line outlet, a diode bridge rectifier 112, a voltage regulator 113, and capacitors C1, C2.

The oscillator circuit 12 includes an integrated oscillator circuit 121 and discrete components, such as resistors R1, R2, VR1 and capacitors C3, C4, C5. The DC voltage output of the DC power source 11 drives the oscillator circuit 12 to generate a pulse train output at the resistor R2.

The driving circuit 13 includes a capacitor C6, a diode D1 and a transistor Q1 which are connected electrically in series. The transistor Q1 has a base terminal connected to the resistor R2. The driving circuit 13 serves to amplify the pulse train output of the oscillator circuit 12.

The primary induction coil 14 is connected across the capacitor C6 so that electric current can be supplied thereto by the driving circuit 13. The primary induction coil 14 generates a magnetic field whenever electric current passes therethrough.

The rechargeable battery device 20 includes a secondary induction coil 21, a rectifier circuit 22, a filter circuit 23, and a rechargeable battery cell 24.

The secondary induction coil 21 is displaceable with respect to the primary induction coil 14. When the secondary induction coil 21 is juxtaposed with the

primary induction coil 14, the magnetic field that is generated by the primary induction coil 14 can induce electric current in the secondary induction coil 21.

The rectifier circuit 22 is connected electrically to the secondary induction coil 21 and includes a capacitor C7 and a diode D2. The rectifier circuit 22 serves to rectify the voltage across the secondary induction coil 21.

The filter circuit 23 is connected electrically to the rectifier circuit 22 and includes a capacitor C8 for filtering the rectified output of the rectifier circuit 22, thereby resulting in a stable DC voltage output.

The rechargeable battery cell 24 is connected across the filter circuit 23 so as to be charged by the DC voltage output of the latter.

When charging the battery cell 24 of the rechargeable battery device 20, the rechargeable battery device 20 is placed adjacent to the charging device 10 such that the secondary induction coil 21 is juxtaposed with the primary induction coil 14. The DC power source 11 converts the external AC line input at the plug 111 into a DC voltage output, and the oscillator circuit 12 is driven by the DC voltage output so as to generate a pulse train output which is amplified by the driving circuit 13. The driving circuit 13 controls the flow of electric current

through the primary induction coil 14, thereby resulting in a magnetic field which induces electric current in the secondary induction coil 21. The voltage across the secondary induction coil 21 is then rectified and filtered by the rectifier circuit 22 and the filter circuit 23, respectively, before being applied to the rechargeable battery cell 24 so as to charge the same.

Figure 3 illustrates an intended application of the rechargeable power supply of this invention. As illustrated, the rechargeable battery device 20 is incorporated in a wireless computer mouse 30, whereas the charging device 10 is provided on a charging base 40 for the computer mouse 30. The secondary induction coil 21 is formed as a planar spiral coil that is disposed on a bottom side of the computer mouse 30. The primary induction coil 14 is formed as a planar spiral coil that is disposed on a top side of the charging base 40. When charging the rechargeable battery device 20, the computer mouse 30 is placed on the charging base 40 such that the secondary induction coil 21 is juxtaposed with the primary induction coil 14.

It has thus been shown that the rechargeable power supply of the present invention does not incorporate electrical contacts, thereby overcoming the drawbacks of corrosion and deformation usually encountered in the prior art. The rechargeable power supply can be

incorporated in different electrical products, particularly in wireless electrical products, such as remote control units.

CLAIMS:

1. A method for charging a rechargeable battery device with a rechargeable battery cell, comprising the steps of:

providing the rechargeable battery device with a secondary induction coil which is connected electrically to the rechargeable battery cell; and

providing a charging device with a primary induction coil which is displaceable with respect to the secondary induction coil and which is capable of generating a magnetic field for inducing electric current in the secondary induction coil when the primary induction coil is juxtaposed with the secondary induction coil.

2. A rechargeable power supply, comprising:

a rechargeable battery device which includes a rechargeable battery cell and a secondary induction coil connected electrically to said rechargeable battery cell; and

a charging device which includes a primary induction coil that is displaceable with respect to said secondary induction coil and that is capable of generating a magnetic field for inducing electric current in said secondary induction coil when said primary induction coil is juxtaposed with said secondary induction coil.

3. The rechargeable power supply as claimed in Claim 2, wherein said rechargeable battery device further includes:

a rectifier circuit connected electrically to said secondary induction coil for rectifying a voltage across said secondary induction coil; and

a filter circuit connected electrically to said rectifier circuit for filtering output of said rectifier circuit.

4. The rechargeable power supply as claimed in Claim 2, wherein said charging device further includes:

a DC power source for providing a DC voltage output;

an oscillator circuit connected electrically to said DC power source and driven by the DC voltage output of said DC power source so as to generate a pulse train output; and

a driving circuit connected electrically to said oscillator circuit and said primary induction coil, said driving circuit amplifying the pulse train output and controlling flow of electric current through said primary induction coil.

5. The rechargeable power supply as claimed in Claim 2, wherein said secondary induction coil is formed as a planar spiral coil.

6. The rechargeable power supply as claimed in Claim 2, wherein said primary induction coil is formed as a planar spiral coil.

7. A rechargeable battery device to be charged by a magnetic field that is generated by a primary induction coil of a charging device, said rechargeable battery device comprising a rechargeable battery cell and a secondary induction coil connected electrically to said rechargeable battery cell, said secondary induction coil being displaceable with respect to the primary induction coil, the magnetic field generated by the primary induction coil inducing electric current in said secondary induction coil when said secondary induction coil is juxtaposed with the primary induction coil.

8. The rechargeable battery device as claimed in Claim 7, further comprising:

a rectifier circuit connected electrically to said secondary induction coil for rectifying a voltage across said secondary induction coil; and

a filter circuit connected electrically to said rectifier circuit for filtering output of said rectifier circuit.

9. The rechargeable battery device as claimed in Claim 7, wherein said secondary induction coil is formed as a planar spiral coil.

10. A charging device for charging a rechargeable battery device which includes a secondary induction coil connected electrically to a rechargeable battery cell, said charging device comprising a primary

induction coil which is displaceable with respect to the secondary induction coil and which is capable of generating a magnetic field for inducing electric current in the secondary induction coil when said primary induction coil is juxtaposed with the secondary induction coil.

11. The charging device as claimed in Claim 10, further comprising:

a DC power source for providing a DC voltage output;

an oscillator circuit connected electrically to said DC power source and driven by the DC voltage output of said DC power source so as to generate a pulse train output; and

a driving circuit connected electrically to said oscillator circuit and said primary induction coil, said driving circuit amplifying the pulse train output and controlling flow of electric current through said primary induction coil.

12. The charging device as claimed in Claim 10, wherein said primary induction coil is formed as a planar spiral coil.

13. The method for charging a rechargeable battery device substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

14. The rechargeable power supply substantially as hereinbefore described with reference to and as

illustrated in the accompanying drawings.

15. The rechargeable battery device substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

16. The charging device substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

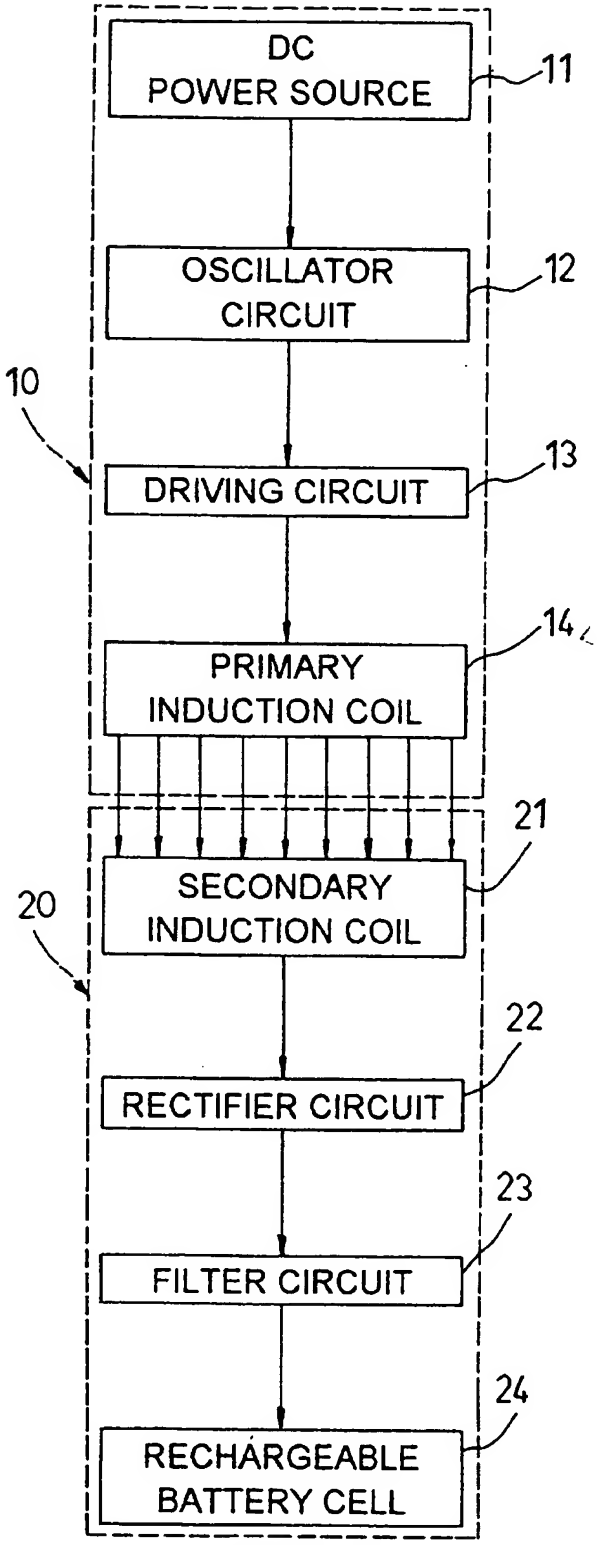
DC
POWER SOURCE
11
OSCILLATOR
CIRCUIT
12
10
DRIVING CIRCUIT
13
PRIMARY
INDUCTION COIL
14
21
SECONDARY
INDUCTION COIL
20
22
RECTIFIER CIRCUIT
23
FILTER CIRCUIT
24
RECHARGEABLE
BATTERY CELL

FIG.1

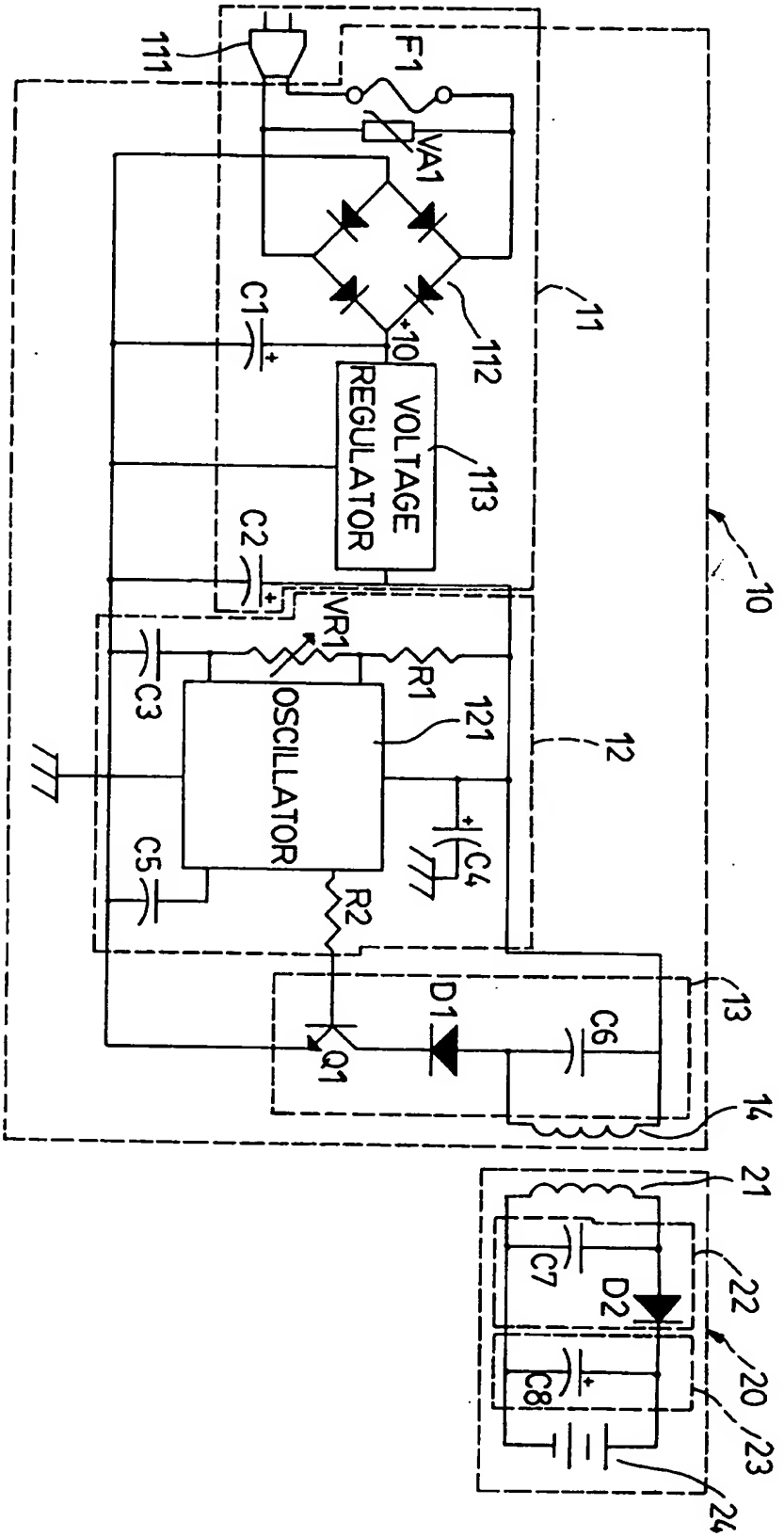
111
F1
VA1
C1
+10
112
VOLTAGE REGULATOR
113
C2
11
10
VR1
R1
C3
OSCILLATOR
121
12
C4
C5
R2
D1
C6
13
Q1
14
21
C7
D2
22
20
C8
23
24

FIG.2

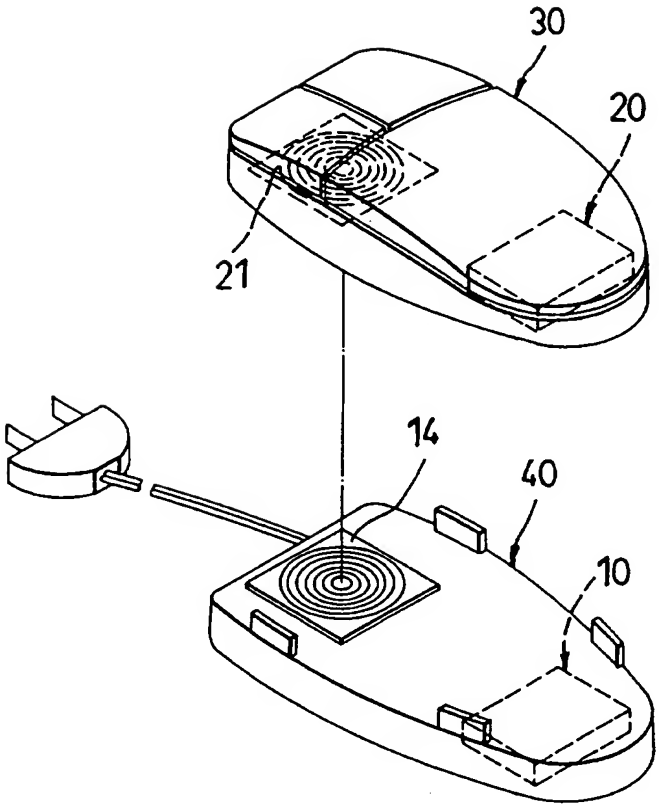

FIG.3

The Patent Office

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Application No: GB 9612663.6
Claims searched: 1 to 16

Examiner: M J Billing
Date of search: 22 August 1996

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Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): H1B B1046; H2H HBCD, HBCE, HBCF, HBCG, HBCH; H3Q QAB, QBRX; H4L LAPS, LECTX.

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Other: ONLINE : WPI.

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB2225197A	(MARCONI) - Fig.1; Abstract	1,2,3,7,8, 10 at least
X	GB2185364A	(LEATHER) - Figs.11,12	1,2,4,7, 10,11 at least
X	GB2094574A	(TRISA) - Figs.1,2; Abstract	1,2,7,10 at least
X	GB2008869A	(MICROSOURCE) - Figs.27-29	1,2,5,6,7, 9,10,12 at least
X	GB1570594	(KOEHLER) - whole document	1,2,3,4,7, 8,10,11 at least
X	EP0552737A1	(HUGHES) - Figs.6-8	1,2,3,5,6, 7,8,9,10, 12 at least
A	EP0171747A2	(METAPHOR) - Fig.2; Abstract, page 14 line 26 to page 16 line 2	13-16

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